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ABSTRACT

This publication presents the activities pertaining to the fifth goal of this activity guide series. The activities in this publication relate to understanding nature and the natural limits to growth, personal consumption practices, and the social and technological implications of rapidly depleting the world's natural resources. These materials are appropriate for middle school and junior high school students. These activities, organized by objective under the concepts listed, are interdisciplinary and can be used in a variety of ways. The activities are simply ideas of things students can do to help them understand the concepts. It remains for the teacher to choose and implement these ideas as desired. Activities range from writing a story explaining what the earth's energy resources will be like by the year 2000 to role playing an election to illustrate how the class can get their views into the government. Some of these activities may be suitable for high school students as well. (MR)

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LIMITS of energy

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ENERGY AND MAN'S ENVIRONMENT

Activity Guide

An Interdisciplinary Teacher's Guide to

Energy and Environmental Activities

Section Five

LIMITS OF ENERGY

John Jones, D.Ed., Editor

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LIMITS OF ENERGY

Introduction

It is axiomatic that almost nothing lasts forever. This is especially applicable to the world supplies of minerals and fossil fuels. Most present sources of energy are finite and can only be used once.

It has been predicted that the United States will use more energy between the mid 1970's and the 1990's than it did in all the years since 1776. The demand for energy is doubling approximately each decade. Obviously a limit must exist as to how much energy we can use in view of the available resources. The limit depends on several interrelated factors, not the least of which is accessibility to the basic energy resource and the price one must pay for it. There are, for example, more barrels of oil available at $12.00 than there are at $6.00, due to the costs associated with removing it from the ground. The same principle applies to most other finite resources.

The energy mix is a good indicator of just which fuels are economic at a given time in history. For example, wood was the dominant source of energy in 1850, but by 1910, 75% of the energy was produced from coal, and wood was down to 10%. By 1960 oil had taken over. Now, because of the increasing cost and the potential scarcity of oil, the United States is returning to coal. As oil becomes more expensive in response to limited availability, it will become too valuable to waste as fuel and instead will be directed to other uses. Clearly, price plays an important role in establishing a limit.

Geological considerations play a significant part in establishing limits. Fossil fuels and other minerals are extremely fortunate geological occurrences. The improbable

sequences of events which formed them continue to occur. However, these processes occur at a much slower rate than man is using them. The formative geological processes occur principally around the edges of present and ancient ocean basins and continents. As a result, the deposits are not equally distributed geographically.

Some people believe that solutions to the supply and demand dilemma will be found in imposing strict limits to growth. Others believe that the solutions will emerge by allowing the world economic system to operate free from constraints. Whatever the solution may be, several factors may play important roles in the final determination of the energy-environmental limits. These include: human population, per capita consumption, re-use of resources, partial conversion to renewable resources (trees, for example), and the development of new technologies.

Activities in this section are largely related to understanding the nature and natural limits to growth, personal consumption practices, and the social and technological implications of rapidly depleting the world's natural resources.

Dan Horn

EVALUATION

Limits of Energy

The ENERGY and MAN'S ENVIRONMENT program actively seeks your ideas, comments, and general suggestions about this Activity Guide. If you feel there are ways this Activity Guide could be improved, or if more or different learning objectives or activities could be added, please let us hear from you. We plan to contact you in the near future to ask your opinion about the activities which you have used in your classroom. In anticipation of our request, we ask that you keep a careful record of all specific activities which are tried in your classroom. Please rate the effectiveness of each activity according to the following scale.

Chapter Title	Concept Number	Objective Letter	Activity Number	not at all useful 1	2	average 3	4	highly effective 5	Comment Suggestion
			EXAMPLE						
Sources	III	B	2					✓	students enjoyed very much
Sources	III	B	5				✓		students enjoyed very much
Uses	II	A	3		✓				too difficult for age level

EVALUATION Limits of Energy

Chapter Title	Concept Number	Objective Letter	Activity Number	not at all useful 1	2	average 3	4	highly effective 5	Comment Suggestion

EVALUATION Limits of Energy

Chapter Title	Concept Number	Objective Letter	Activity Number	not at all useful 1 2 average 3 4 highly effective 5	Comment Suggestion

EVALUATION Limits of Energy

Chapter Title	Concept Number	Objective Letter	Activity Number	not at all useful 1 2 average 3 4 highly effective 5	Comment Suggestion

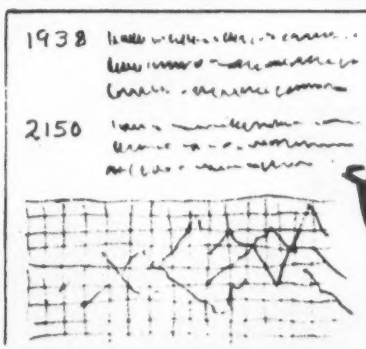
concept: I - All sources of energy are limited; most can be used only once.

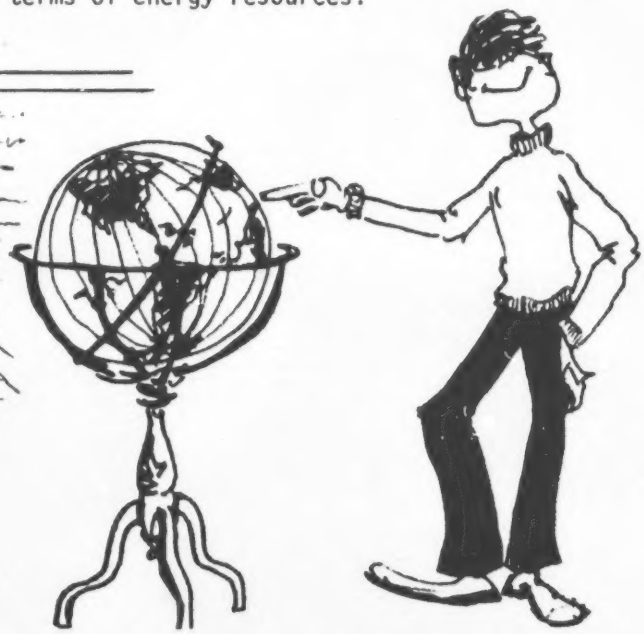
limits

objective: A - The student will understand what is meant by "limited" as related to energy resources.

activities

1. State examples that describe the earth as essentially a closed system so that its ability to provide energy resources is finite.
2. Describe the limits of the earth's energy resources, using a chart or graph.
3. Graph the supply of the known world's reserves of uranium from 1938 to 2150.
4. Predict the duration of supply of various sources if use continues at current rates.
5. Contact your state geological survey department to determine your state's reserves of energy. Make a bar graph showing total reserves.
6. Contact your state geological survey department to determine use of energy in state. Predict year of exhaustion for each source.
7. Give examples of resources which can last indefinitely if wisely used (renewable).
8. Write a short story explaining what the earth will be like in the year 2000 in terms of energy resources.





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concept: I - All sources of energy are limited; most can be used only once.

limits

objective: B - The student will understand the terms "recycle" and "reuse."

activities

1. Visit a glass bottle factory; report on difference between re-used and recycled bottles.

2. Compare amounts of energy required for twenty uses of reused and recycled bottles.

3. Describe materials (iron, glass, aluminum, etc.) in terms of their ability to be reused. Include amounts of energy required to collect and prepare for reuse.

4. Visit your local sanitary landfill. Obtain information regarding the quantity of disposable material. Report to the class the feasibility of recycling materials found there.

5. Conduct a panel or debate regarding use of bottles and cans. Discuss the feasibility of recycling centers in your community.

6. Organize, "sell" and conduct a cleanup and recycling campaign in your school or community.

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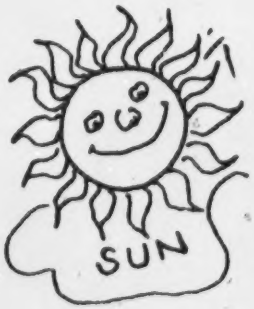
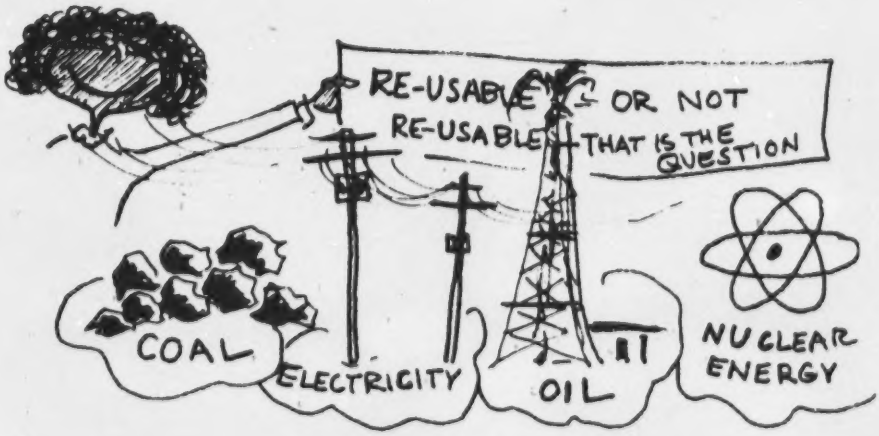
concept: I - All sources of energy are limited; most can be used only once.

limits

objective: C - The student will determine what forms of energy cannot be reused.

1. Describe basic factors which determine whether a form of energy can be reused or not.
2. Visit a reusable energy source. Describe it.
3. Make a scrambled word puzzle using examples of energy that cannot be reused. Have other students find and list them.





activities

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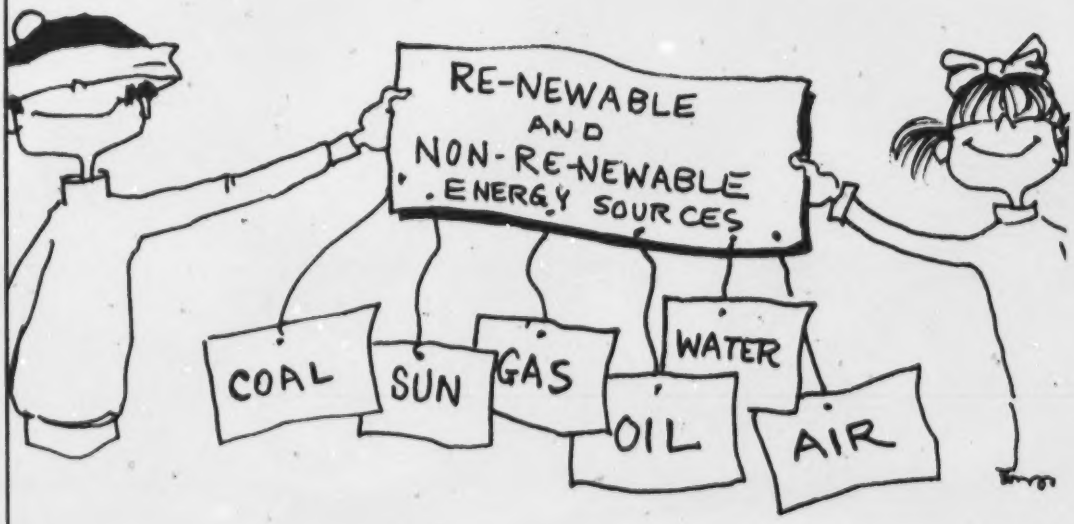
concept: I - All sources of energy are limited; most can be used only once.

limits

objective: D - The student will be able to describe the difference between renewable and nonrenewable energy resources.

activities

1. Construct a model which demonstrates a form of reusable energy.
2. Write a report or give an oral report on renewable and non-renewable energy resources.
3. Prepare a bulletin board display showing different types of renewable and nonrenewable energy resources.
4. Prepare a display showing renewable and nonrenewable energy resources.



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concept: I - All sources of energy are limited; most can be used only once.

limits

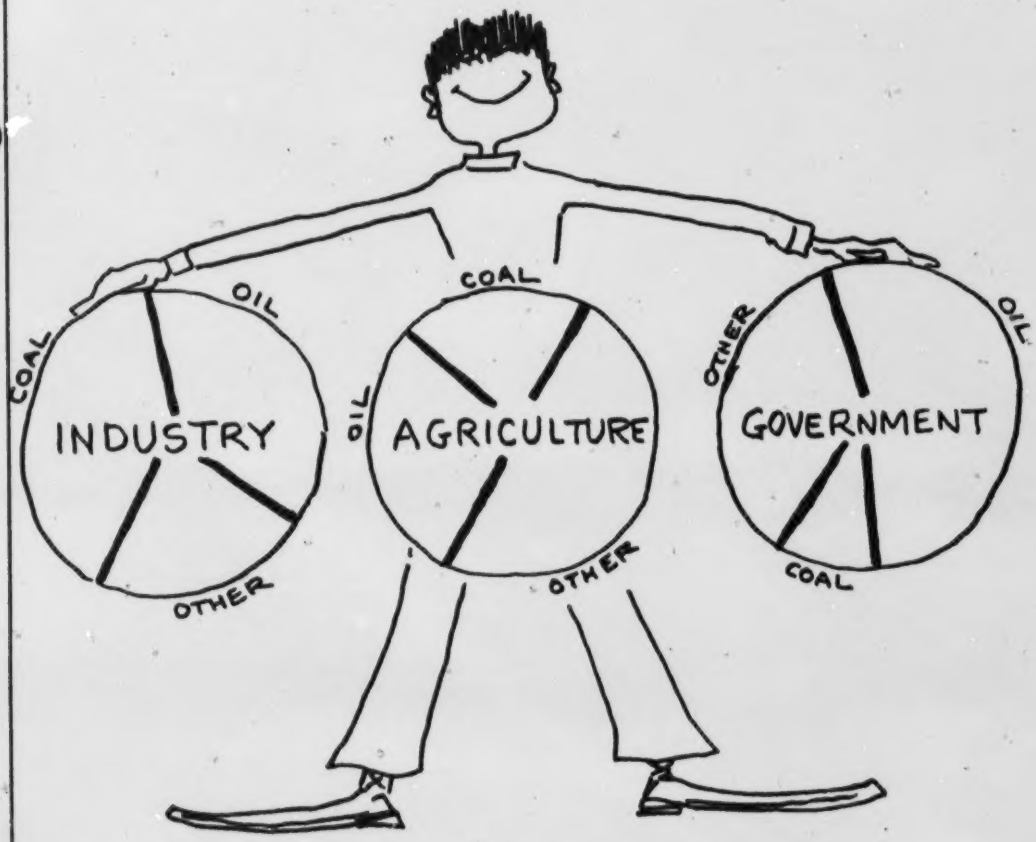
objective: E - The student will be able to explain how renewability or nonrenewability affects energy availability.

activities

1. Contrast renewable and nonrenewable resources, including but not limited to fuel, minerals and other energy sources.

2. The question about energy reserve is not "How long will energy last?", but "How long will energy serve as sources for mankind?" What does this mean, and what is your reaction?

3. Using the charts on page 111 of "The Biosphere", Scientific American, W. H. Freeman Co., 1970, prepare a chart showing the probable duration of the use of coal, oil and natural gas if future use is at the 1970 rate; then at the year 2000 rate.



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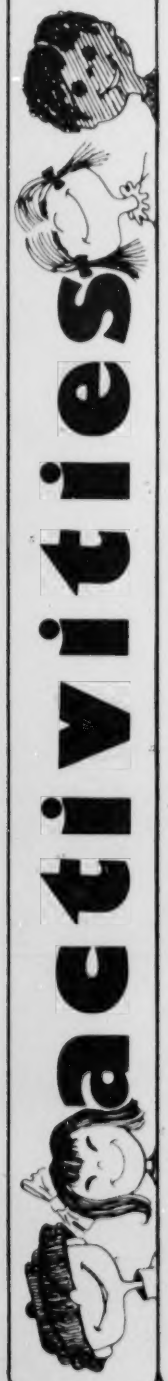
concept: I - All sources of energy are limited; most can be used only once.

limits

objective: F - The student will be able to discuss personal activities which would extend the availability of nonrenewable energy resources.



1. Have a debate on this topic: "Resolved: Family structures change in response to limited energy resources." For example, what else is there to do if there isn't electricity for the television set?

2. Assume that a definite amount of energy is allotted to meet all your physical and psychological needs. Assume that amount of energy is about half which you presently consume. How would you modify your life style to conform to the energy available?

3. Research the life styles of the Australian aborigines, the Eskimos and the Kalahari Desert tribes. What are their energy resources? What implications are there for us if we are faced with severely restricted energy resources? How would you modify your life style? Justify the choices.

4. Pick one favorite possession which is made of man-made material (plastic or synthetic fiber). Also, select a short motor trip you would like very much to take.

   Decide between the trip and the possession. Defend the choice on the basis of expenditure of fossil resources. The trip would take energy and fossil fuel, and so did manufacture of the possession.

5. Evaluate the minimum amount of energy a person needs for bare existence.

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concept: I - All sources of energy are limited; most can be used only once.

limits

objective: G - The student will understand the relationship of "life style" to "finite energy resources."

activities

1. Relate the standard of living in a highly industrialized society to the prospect of further limits of available energy resources, i.e., what will happen as resource competition grows?

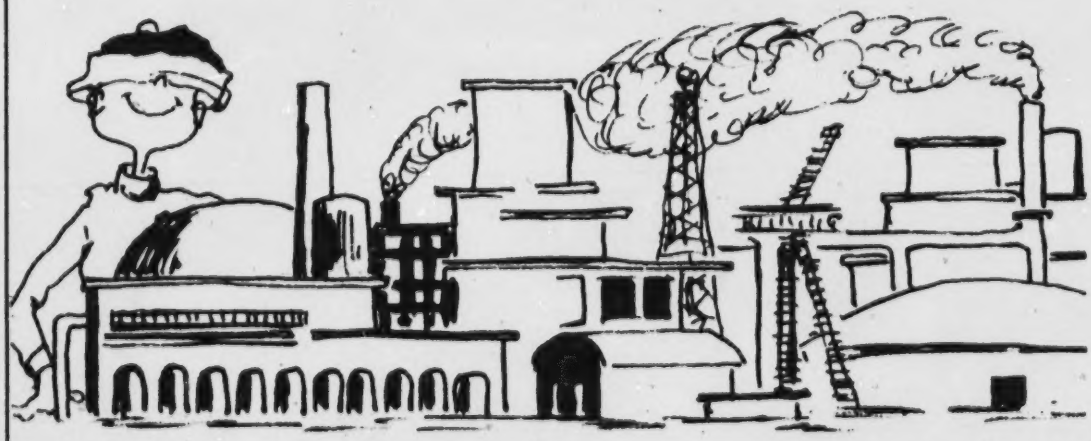
2. Discuss the limits to exponential population growth in a closed system. Included should be the limiting factors of available nutrients (food), atmosphere and suitable habitats (substrates for attached marine organisms to housing and medical care for people).

3. Write a poem about "life styles 1980."

4. Make a collage of pictures showing your life style.

5. Make a banner with a symbolic representation of your life style.

6. Speculate on changing life styles in Iran, Venezuela, or any of the Arabian countries as an outcome of increased oil demands/prices. Check your speculations with current reports in periodicals.



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concept: I - All sources of energy are limited; most can be used only once.

limits

objective: H - The student will identify natural systems and describe their components.

activities

1. Describe the components of an ecosystem.
2. Place into a large glass jar which can be sealed, a goldfish, a few small snails, pond water and pond plants. What is necessary to make this ecosystem work? Try it, using a control.
3. An ecosystem is a discrete community of organisms consisting of organisms which are producers, consumers and decomposers. The student will identify an ecosystem on the school's property. Identify in the system organisms which perform each function.
4. Probably the ecosystem being observed has been disturbed by man. Compare the present ecosystem with the pre-man ecosystem. What will happen if man is again eliminated from the system?
5. Describe the physical effects on the ecosystem if energy were to be available to man on an unlimited scale.
6. Describe energy flow and entropy in an ecosystem.
7. Describe a natural hydrologic energy system. Describe a man-made hydrologic energy system (e.g. pumped storage).

   Discuss these systems in terms of efficiency, practicality, desirability, etc.
8. Diagram the fossil fuel energy systems (coal, oil, natural gas).
9. Compare natural gas and manufactured gas for energy efficiency.

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concept: I - All sources of energy are limited; most can be used only once.

limits

objective: I - The student will describe ways that man has upset natural systems in his quest for energy.

activities

1. Set up a large jar containing pond water, snails and fish, but no plants. Seal the jar. Theorize what will happen in this system. Give reasons. Observe and record observations for several days. Was the theory substantiated by the results? Why did this occur?

2. In nearly all geographic areas of the U.S. there are fish hatcheries. These hatcheries have been established as an artificial system to help reestablish fish life in lakes, ponds, streams and rivers. How do these hatcheries help save fish from extinction and are they worth the cost to maintain? Do you feel this is the best way to proceed? Why?

3. Display pictures showing how man has upset the natural systems in your community.

4. Visit a hydroelectric dam. Compare the river - natural system as it was before the dam was built to present conditions. Clarify tradeoffs made consciously and unconsciously by decision to build the dam.

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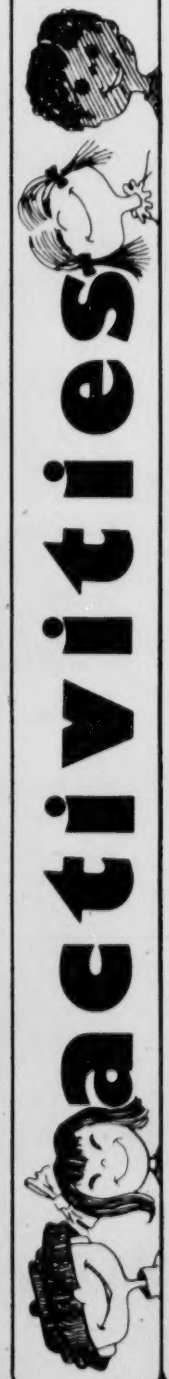
concept: I - All sources of energy are limited: most can be used only once.

limits

objective: J - The student will understand the flow of energy from source to consumer.

activities



1. Note differences in energy flow by setting up several aquaria, each containing the same weight of living materials. The simplest aquarium may consist of a quart jar innoculated with algae and minerals.

   (Teacher's instruction: Chlorella and Knopps Solution are suggested. Primary students may use pond water that is green.)

2. Place one aquarium in full sunlight during the day and under a lamp at night. Place another aquarium in the presence of sunlight only or lamp only. Place another aquarium in complete darkness. After several weeks note and record the differences. The intensity of the green color can show the difference in the quantity of life.

3. A quantitative measurement may be made by organizing a serial dilution series of a green food coloring dye. Each solution is one-tenth the concentration of dye in water as the preceding solution. By comparing these defined standard solutions to the aquaria, the relative quantity of the algae may be estimated. Record and interpret the results.

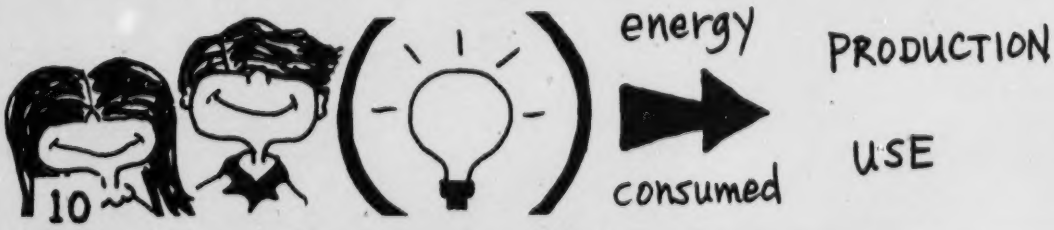
4. Measure the quantity of energy absorbed. Light meters may be used to show the degree of intensity. Artificial sources of illumination should be used to control completely the energy sources.

5. Graph the relationship between quantity of energy and quantity of organisms. A weight of organisms may be obtained by centrifuging samples from each aquarium, decanting the supernatant liquid, and weighing the contents.

6. Make a bulletin board display, showing the flow of energy in the biosphere.

   Make a bulletin board display, showing the hydrologic cycle.

   Make a bulletin board display, showing the conversion of solar energy to various other types of energy.



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concept: I - All sources of energy are limited; most can be used only once.

limits

objective: K - The student will determine the flow of man-influenced energy conversion products into and through a natural system.

activities

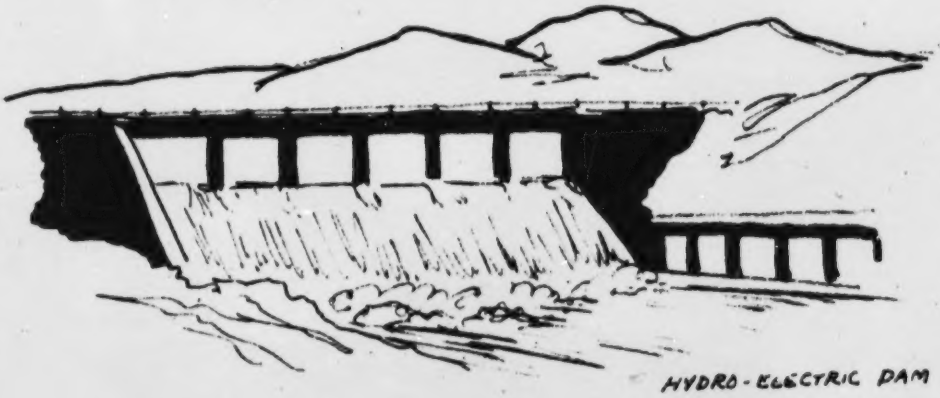
1. Diagram various energy conversion systems. (Add others suggested by class discussion and investigation.)

   Hydro ⟶ electricity ⟶ use
   Gas ⟶ electricity ⟶ use
   Coal ⟶ electricity ⟶ use
   Electrical ⟶ mechanical (e.g. motor)
   Gas ⟶ mechanical (e.g. engine)

2. For each of the above, calculate the amount of energy lost in each conversion. Calculate efficiency of each system.

3. Compare two sources of usable energy, one direct, and one indirect (one conversion).

   Discuss relationship of the two sources.



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concept: I - All sources of energy are limited; most can be used only once.

limits

objective: L - The student will understand how natural systems accommodate products from man's use of energy.

activities

1. Visit, study and report on a lake which has become eutrophic.
2. Design limits on uses of energy which will allow the lake to recover.
3. Create a cartoon, a play, a poem or song that will help others understand the statement: "Dilution is not the solution to pollution."
4. Determine where the products of combustion from automobiles in your community go when there is a strong west wind.
5. If one million gallons of petroleum are burned per day by automobiles, what are the products of that combustion and what are their amounts? Report on this phenomenon in a way that uses more than one person and utilizes pictures.

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concept: I - All sources of energy are limited; most can be used only once.

limits

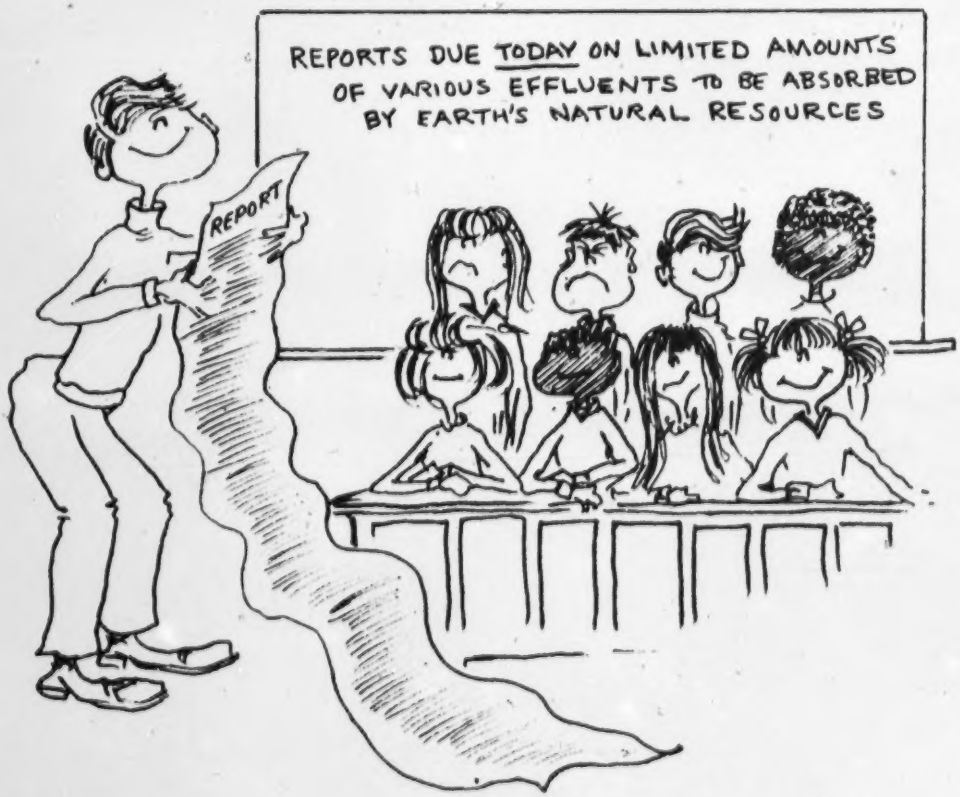
objective: M - The student will understand the limits on energy use caused by the ability of earth's natural systems to accommodate effluents.

activities

1. Research and quantify the kinds of effluents produced by various energy sources - natural and man-made.

2. Study and report on the limited amounts of various effluents which can be absorbed by the earth's natural resources, (e.g. lakes, oceans, rivers air, landfill, etc. Size must also be considered).

3. Identify and describe the limits the growing system will meet next, assuming technological advances could remove some natural limits to energy resources.



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concept: II - Some energy sources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.

limits

objective: A - Fossil fuels are replaced within the earth in minute amounts each year.

activities

1. Diagram the developmental stages of a coal bed starting with tree ferns of the Carboniferous Period of the Paleozoic Era.

2. In an encyclopedia or appropriate textbook look up Paleobotany. Find out what kinds of plants were on the earth during the Carboniferous Period. Are the same kinds of plants common on the earth today? Does this tell us whether or not coal is being formed now?

3. Petroleum is extracted from the earth in regions which were once underwater. Find out how the petroleum got there.

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concept: II - Some energy sources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.

limits

objective: B - Wood is a resource which is renewed rapidly within a human lifetime.

activities

1. Draw a map of your county (or state) showing which part was covered by forests 200 years ago; draw a second map showing forest distribution in your state today.

2. Find out who owns and/or controls the forested areas of your county and state. These might be private individuals, corporations, the U.S. Forest Service, the state, or others. Do the different owners seek to renew this resource or not?

   To help find answers to this you might start by using the Environmental Program for the Future, published by the Forest Service of the U.S. Department of Agriculture. A draft copy was prepared in June 1974. You may be able to get a more recent copy.

3. If you were in the business of raising trees as an energy source, what kind of trees would you raise? In what region would you choose to raise them?

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concept: II - Some energy sources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.

limits

objective: C - Falling water is a renewable resource.

activities

1. Man has used water as an energy resource for thousands of years. What are some primitive ways of using water to get energy? Make a working model of two early uses and demonstrate their use to your class. Demonstrate for a class of younger children.

2. Using a large jar or a bowl with clear dome (glass or plastic) make a simple model of the hydrologic cycle. What is the energy source that powers the natural hydrologic cycle? Position your model so that it uses the same energy source.

3. Using almanacs or streamflow charts from the U.S. Corps of Engineers or data from local weather bureaus, graph the annual discharge rate of the river or stream closest to you. Does this suggest that falling water is a constant or a changing source?

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concept: II - Some energy sources are rapidly renewed while others are renewed so slowly as to be practically nonrenewable.

limits

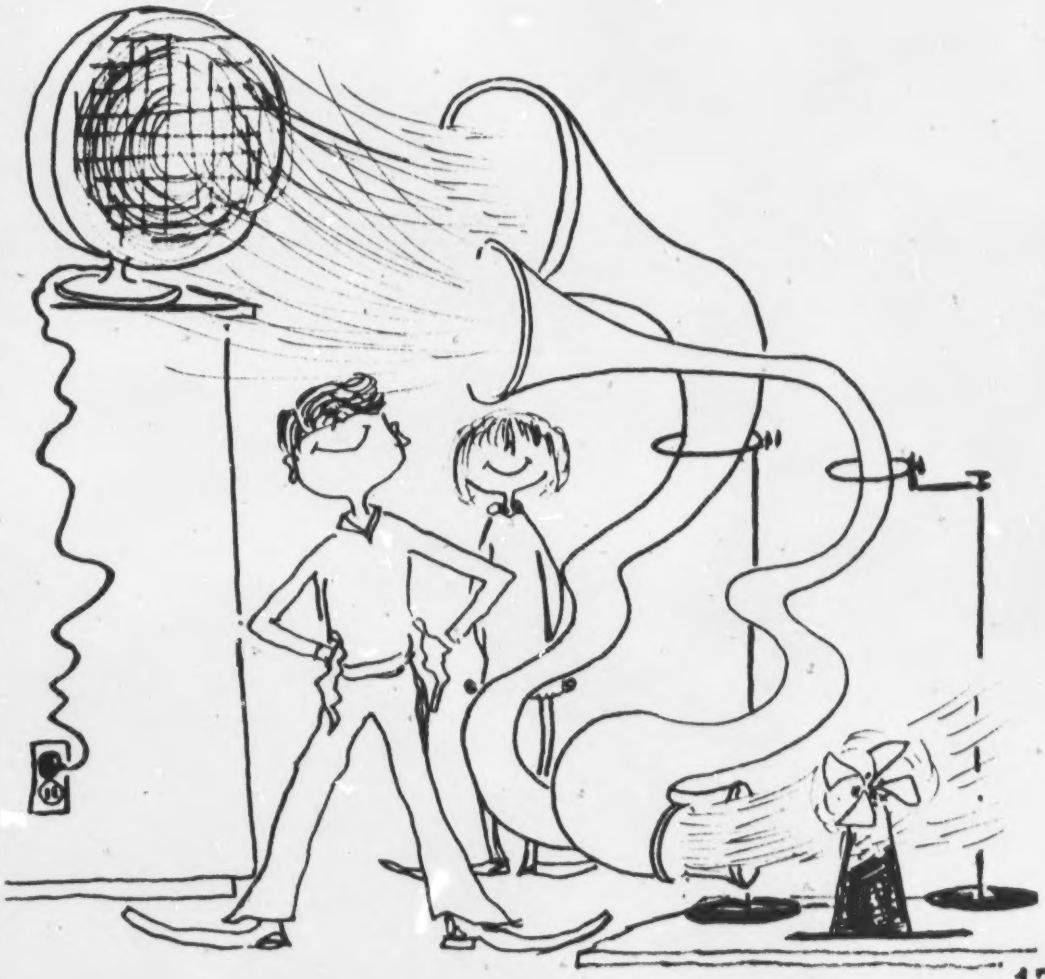
objective: D - Moving air (wind) has been and is an energy source in many parts of the world.

activities

1. Make a chart, a mural or a set of models showing ways of capturing wind for the energy of its motion.

2. Write a story about a time when the wind failed to act as a renewable resource.

3. Make a model or map of your community showing where you would place windmills to provide the community with the maximum energy which could be derived from wind power. Would this be a good energy source for your area?



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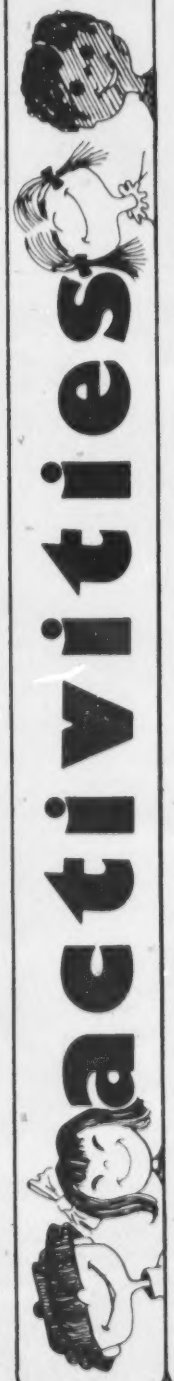
concept: III - Limitations may be viewed as relative to changing energy demands.

limits

objective: A - The student will understand the effects upon energy availability of various political (social), economic or environmental systems.

activities



1. Assume all energy resources were cut in half. List the ways in which your local government would be affected.

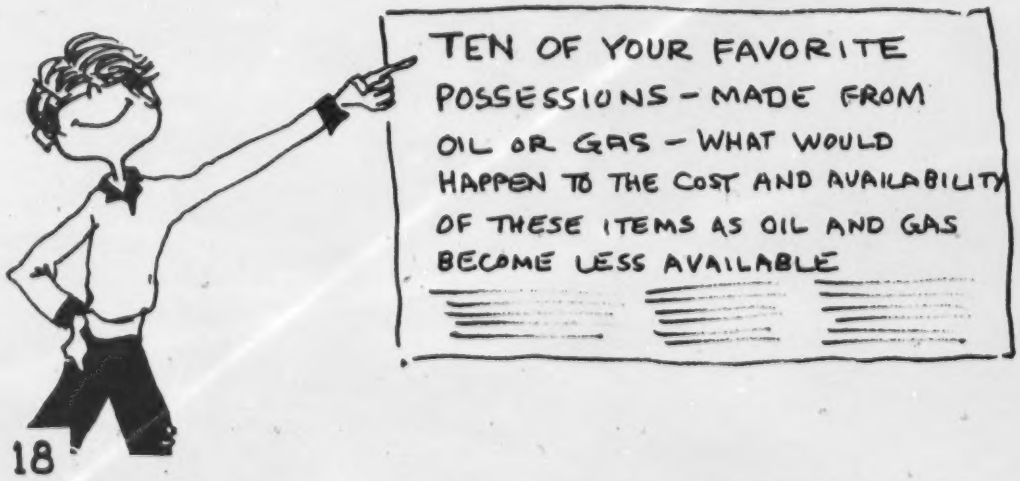
2. Among the few renewable energy resources is wood fuel. However, abuse could quickly make it nonrenewable. To prevent a total loss of wood as both an energy source and a building or shelter, public policy has required that national forests be harvested so that the forests can be renewed. Man has not always followed this policy. Attempt to discover which ancient and modern civilizations lost their forest resources. Discuss how the renewal of forest resources either helps or hinders individuals and societies.

3. Discuss ramifications of the Middle East countries refusing to sell oil resources to the United States. List five ways in which this would affect one's personal life.

4. When a resource becomes more scarce, the law of supply and demand forces up the price. When it is too expensive for most users, there is a shift to a replacement resource. The shift from oil and gas to coal for the generation of electric power is an example.

   List ten of your favorite possessions that are made from oil or gas (synthetic fibers, plastics) and then discuss what might happen to the cost and availability of these items as oil and gas become less available.

5. Investigate ways that a tax could be applied on a resource itself, on the use of it, or on points of distribution.



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concept: IV - Knowledge and technology help develop and extend past, present and future energy resources.

limits

objective: A - The student will know factors that limit the technological growth and development of new energy sources.

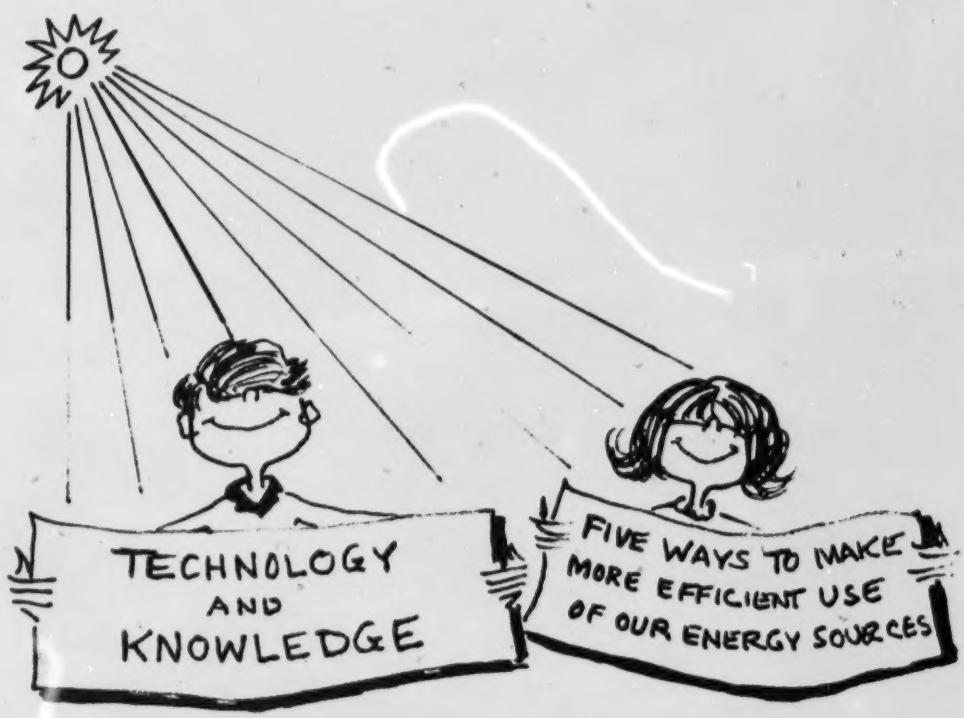
activities

1. Do all societies value technological advances? Discuss the ethics of forcing one's technological orientation on nations or societies which do not have it.

2. Prepare a report stating why the Centralia Power Plant is not operating at 100% of its capacity (or a new facility in your area).

3. Find the average length of time it takes to build a nuclear electric plant in 1975 or 1976 from the date a company proposes it until it is in operation. How long did it take to plan and build nuclear electric plants in the 60's? Investigate reasons for the increased development time.

4. In an encyclopedia look up solar energy. How long has it been in use for heating water and/or homes in the U.S.? What has limited its widespread use in southwestern states?



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concept: IV - Knowledge and technology help develop and extend past, present and future energy resources.

limits

objective: B - The student will know examples where more efficient utilization of available energy is limited by man's ignorance or by lack of demand.

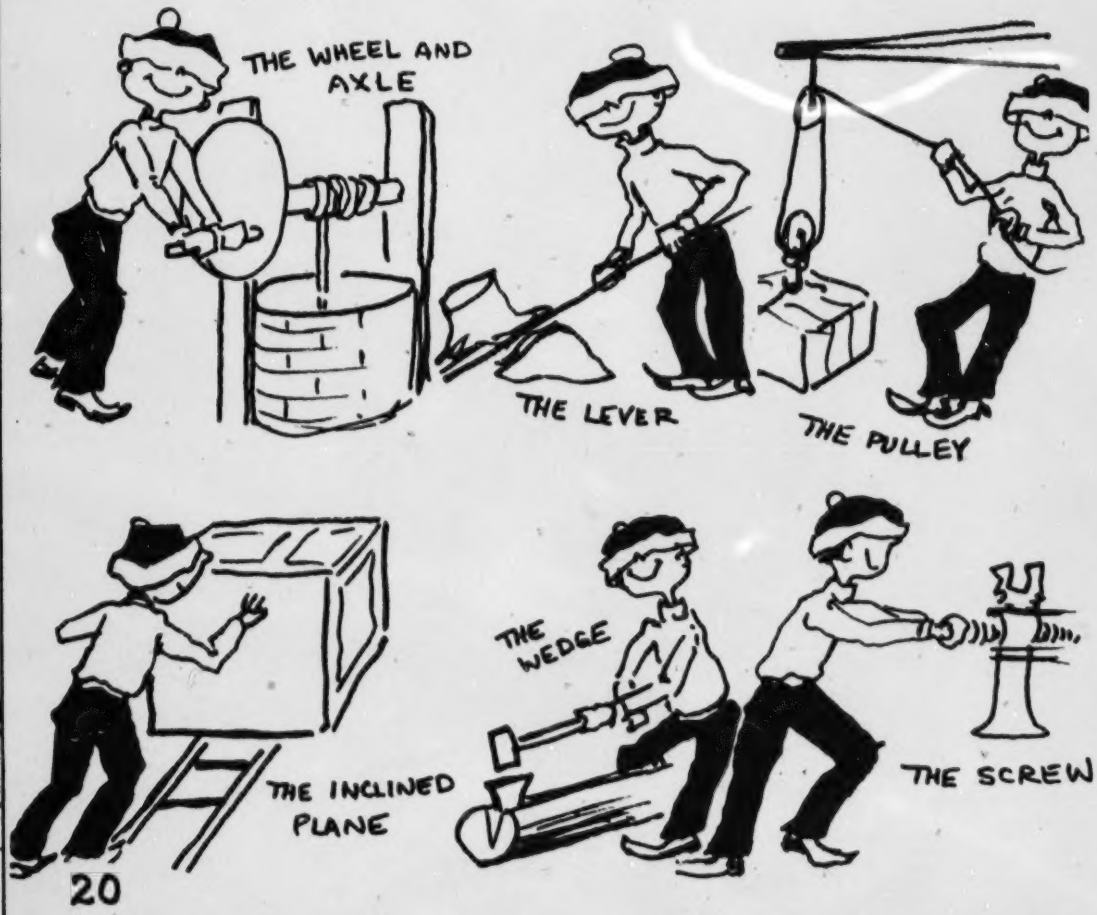
activities

1. Discuss the invention of simple machines, such as the lever, wheel. Consider why man took so long to develop these.

2. Plan a low net-energy farm operation and identify farm operations that could be improved by more efficient use of energy resources. Identify how to accomplish those operations with a lower energy input. Describe the problems inherent in doing this.

3. Investigate the development of the steam engine.

4. Discuss the merits of land-use planning to ease population pressure and to utilize energy resources more efficiently.



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concept: IV - Knowledge and technology help develop and extend past, present and future energy resources.

limits

objective: C - The student will know how a nation has overcome limitations of energy supplies.

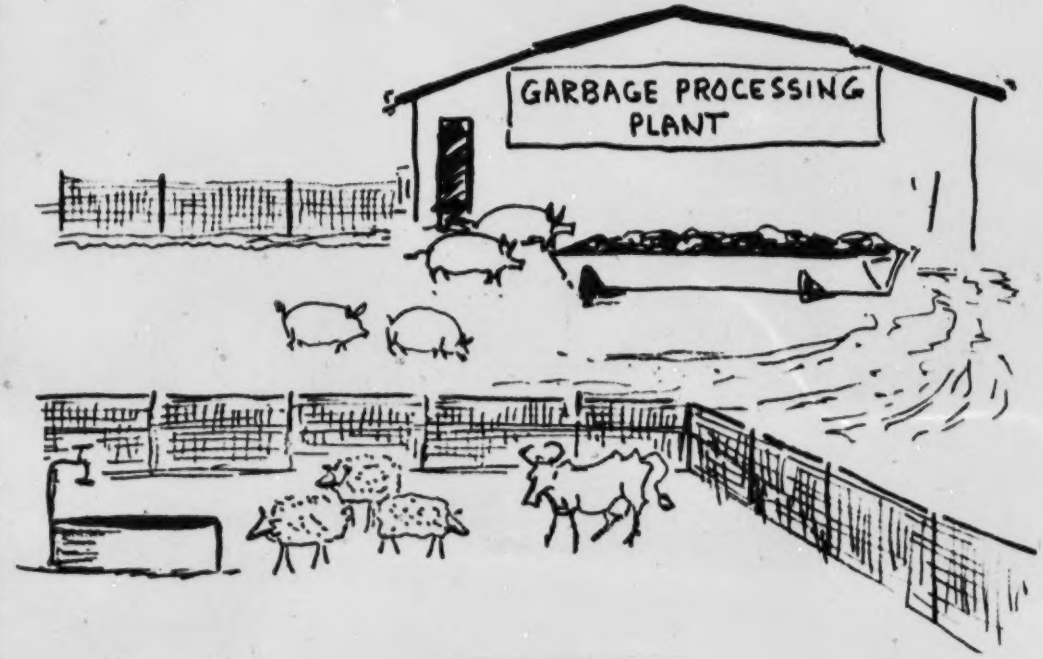
activities

1. Construct a set of guidelines for the use of rapidly diminishing sources of energy (i.e., should fossil-energy resources be used to depletion as a fuel source?)

2. Describe possible effects on ecosystems if man uses nonrenewable energy resources to maintain the proper relationships between artificial systems, equilibrium systems, and systems undergoing repair on this planet.

3. Assume that it becomes more important to feed available grains to people than to animals. Propose a plan for processing garbage to provide food for cows, sheep, pigs and chickens. List the new occupations that will result from this processing plan.

4. Research the development of nuclear based energy sources for transportation systems. Report your findings to your classmates, and ask them to react verbally to the conclusions of your research.



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concept: IV - Knowledge and technology help develop and extend past, present and future energy resources.

limits

objective: D - The student will understand how start-up time lag limits the availability of new energy sources.

activities

1. Graph the relationship between the development of an energy resource and time.

2. List and describe the factors affecting "start-up time."

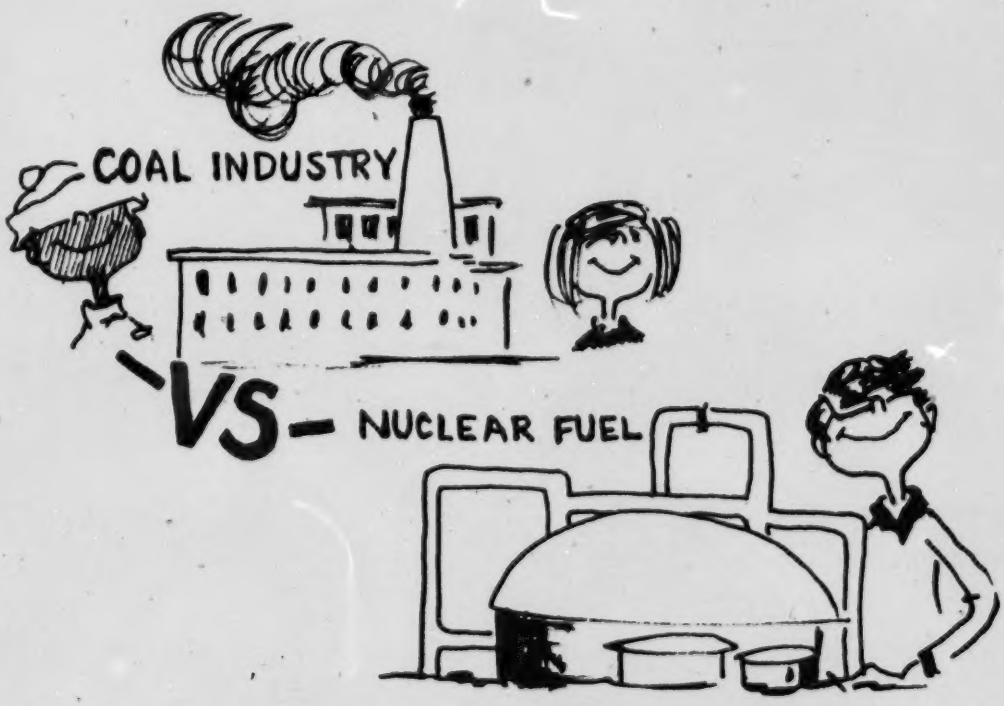
3. Construct a visual display comparing the development of a coal based industry to one based on nuclear fuel.

4. Visit the Centralia Power Plant, the Jim Bridger Plant or a new facility in your area.

   a. Construct a display showing how long it took to get it operating, using photos and diagrams (month by month).

   b. Report on how long the plant will produce energy, based upon coal reserves, life of the generating and furnace equipment, and other potential energy sources (coal, peat, garbage).

   c. Investigate and report on the efficiency of its operation.



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concept: V - Economic factors limit energy development and use.

limits

objective: A - The student will understand why there are economic constraints on development of energy sources.

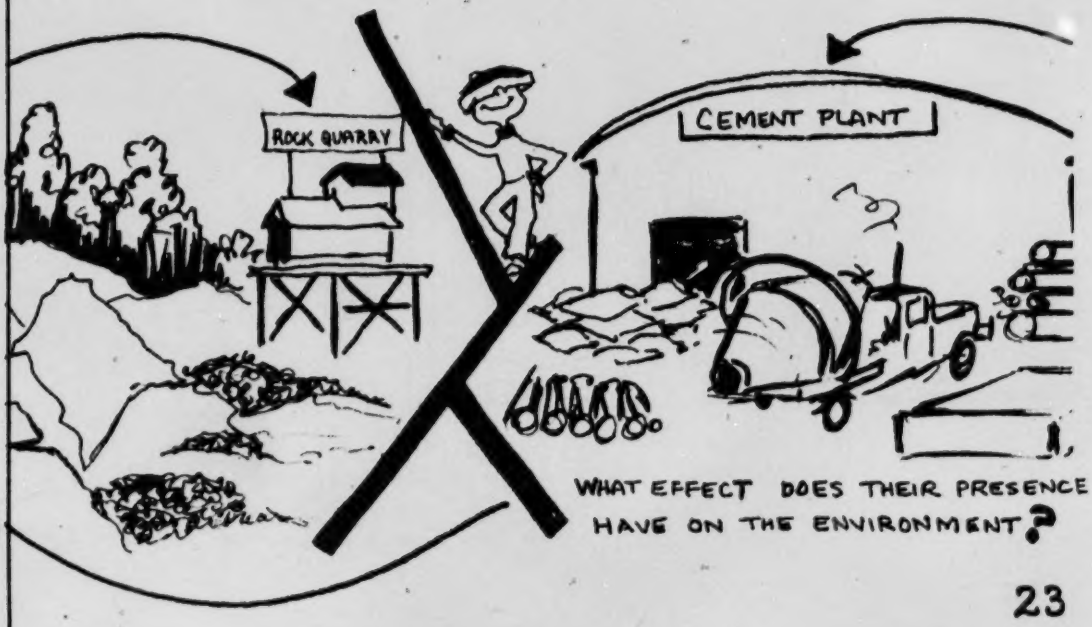
activities

1. Visit a gravel quarry and a cement plant in the area. Discuss the desirability of locating these operations near centers of population (cost, transportation, jobs, etc.). Discuss the conflicts that could occur between these operations and the expansion of the suburbs, other industrial operations, and agriculture. What effect does its presence have on the environment?

2. Read the Wall Street Journal daily for a month. Select articles from the Wall Street Journal that inform you about capital investment in energy resource development. Select data from those articles that mention constraints or limits on investment. Report on these findings, using a media of your choice.

3. Discuss how economic limits on energy resources can extend the useful life of the resource.

4. Research the historical development of the oil industries in Iran and the Arabian Gulf countries. Why were the U.S. and the United Kingdom so deeply involved? With the historical facts at hand carry out a debate between the Economic Minister of Saudi Arabia and the delegates from western oil company representatives.



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concept: V - Economic factors limit energy development and use.

limits

objective: B - The student will understand the economic benefits which result from either the development of new energy sources or changes in present sources.

activities

1. Describe the relationship between limited energy resources and international trade.
2. Illustrate with a montage or collage how the use of oil in your local community has contributed to your standard of living.
3. Imagine living in a community near an oil shale development. Create and explain a business that would be profitable in terms of economic changes in your community.
4. Research and predict kinds of new jobs created or renewed as the result of severe limits placed upon energy use.

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concept: V - Economic factors limit energy development and use.

limits

objective: C - The student will understand how dependence upon one energy source, domestic or foreign, is more limiting than development of a wide variety of energy sources.

activities

1. Research and report on various energy sources available in your community, state or nation.

   Determine the most desirable "mix" of energy sources based upon unlimited resources and capital, limited resources and limited capital.

2. Compare the advantages and disadvantages of using fossil hydrocarbon resources as a base for synthetic production rather than as a fuel.

3. Study the relationship between a nation's economy, industry, and sources of energy.

4. Make a chart showing a food web and a food chain in a pond environment. Remove an organism (other than the top consumer) from the food chain and then remove the same organism from the food web. Discuss the relative results.

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concept: V - Economic factors limit energy development and use.

limits

objective: D - The student will understand how the flow of dollars spent on energy sources affects the limits on energy use, conservation and waste.

activities

1. Study the cost of developing a new energy source. Include exploration, development and transportation costs.

2. What energy factors most influence a decision to locate an industry? Consider various kinds of industry.

3. Describe the flow of dollars spent on energy resources in your community.

4. The local stores have all announced that due to a transportation strike there will be no more candy bars for an extended period of time.

   What will happen to the present supply? How will the supply be distributed? Will there be restrictions as to how many bars each person will be permitted to buy? What will happen to the price? What will happen to you emotionally if there are no restrictions and someone ahead of you buys the last box of bars? What will you be willing to do to get some of those bars?

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concept: V - Economic factors limit energy development and use.

limits

objective: E - The student will know the cost of energy in various societies.

activities

1. Find the average wage per hour for a worker in each of the following countries: Italy, Germany, England, Russia, and Australia. If a litre of gasoline costs one dollar in the United States, how long would the worker in each country have to work to purchase 10 litres?

2. Determine the effect on various societies of each situation below:

   a. An increase in cost of each energy source now in use.

   b. A decrease in cost of each energy source now in use.

   c. A loss of an energy source currently depended upon.

INCREASED COSTS!

THERE'S AN END TO IT SOMEWHERE!

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concept: V - Economic factors limit energy development and use.

limits

objective: F - The student will understand the economic effects of uneven distribution of energy resources in the world.

activities

1. Contrast the immediate and long-term effects on the people of Saudi Arabia and Kuwait by the discovery and exploitation of oil in their countries.

2. Discuss the influence on world trade as an underdeveloped, resource-rich nation moves toward greater development.

3. On a world map color those areas rich in mineral resources. On an overlay indicate the highly industrialized areas so the relationship can be noted.

4. What advantages might be derived from more equalization of income and consumption relative to production and resources? What should be the responsibilities of each nation in terms of population control, resource consumption and income sharing?

5. Relate the cost of energy use to the cost of transporting it to where it is being used.

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concept: V - Economic factors limit energy development and use.

limits

objective: G - The student will understand that it takes energy to make energy.

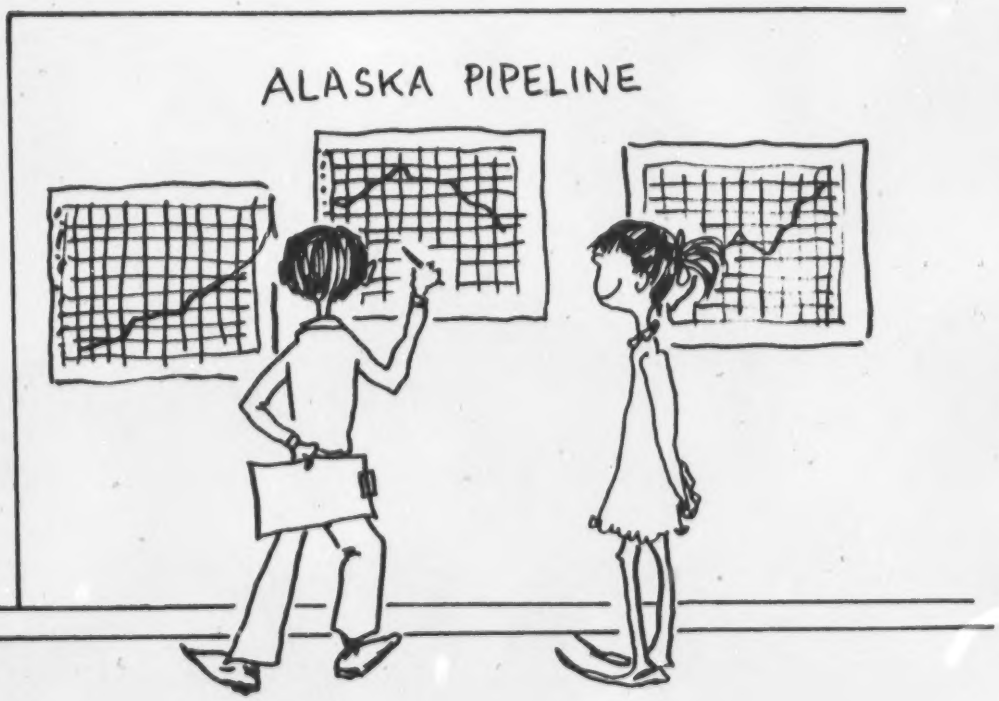
activities

1. Determine the cost of building a nuclear power plant. Where does the money come from?

2. Using the reference "Understanding the National Energy Dilemma", estimate or determine how much energy will be used daily to move oil along the Alaska pipeline in 1980 by interpretation of the graphs.

3. Determine what companies invested capital in the Alaska pipeline. How much did each company invest? Where did the money come from?

4. Calculate the amount of energy used to mine, transport and prepare the coal in the Centralia coal fields, and compare to the amount of energy eventually produced.



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concept: V - Economic factors limit energy development and use.

limits

objective: H - The student will understand the need to use non-energy resources in developing energy sources.

activities

1. In order to have electricity in your home what materials must be used? Starting with your electric meter work back to the generating station via the electric wires (transmission lines), utility poles, transformers and all other necessary parts, listing the materials that are essential for their production.

2. If you are served by a hydroelectric generation station what materials are/were needed for its construction and maintenance?

3. If your electricity is generated by fossil fuels, what materials were essential for construction and maintenance of the plant?

4. Get a speaker from a local utility company to tell your class about the manufacturers and suppliers on whom it depends.

5. Compose a letter to the production department of a large oil company asking what other industries it depends on for materials and services.

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concept: VI - Population change directly influences energy use, availability and supply.

limits

objective: A - The student will understand the correlation between population change and energy consumption.

activities

1. List energy related services that would need to be instituted, and those that would have to be abandoned, as a result of overcrowding.
2. Describe why resources around centers of population often are depleted or overused.
3. Develop a graph showing population and energy changes. Increase population while energy remains constant, and increase energy while population remains constant.
4. Debate population control: "Resolved: Population control is necessary."
5. Use a role-playing experience to study a society where no one can have more than two children; one family wants more. They are appealing to the family planning board.
6. Give examples of limits to exponential growth in a closed system including examples of nutrient cycling, space and energy sources.
7. How can the concept of a limited earth (the spaceship metaphor) assist us in planning our population size?

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concept: VI - Population change directly influences energy use, availability and supply.

limits

objective: B - The student will know the relationship between the standard of living and the limited availability of energy.

activities

1. List examples of restraints that might result from over-population.
2. Observe fruit flies in a contained bottle. Make a population count each day. The supply of sugar will not be exhausted before the bottle is crowded with organisms and the population ceases to grow.
3. Describe implications for the quality of life under severely restricted energy resource conditions.
4. Describe aesthetic impact on natural resources, e.g. recreation development, urbanization, mineral exploitation.
5. Discuss how overcrowding can lead to psychological stress.
6. Discuss how stress might lead to competition for the basics of existence, recreational facilities and educational facilities.
7. Describe the aesthetic aspects of mass production of animals in feedlots.
8. How could the concept of a limited earth aid ultimate population-carrying capacity and help us predict the quality of life for future generations?

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concept: VI - Population change directly influences energy use, availability and supply.

limits

objective: C - The student will understand the impact of limited energy supplies on the individual.

activities

1. Arrange the students in the class equidistant from one another all over the room. After three minutes, discuss their reactions to occupying the space allotted. Then have all of the students move into half the room, and after three minutes, discuss reactions. Keep halving the available space until about two square feet per student are reached. Discuss the problems of congestion due to overpopulation.

   Discuss the responses to the prospect of living continuously in the school situation with its attendant human congestion.

2. Study the flatworm Planaria. Planaria which are well-fed with liver increase in size and population. But planaria which are cut and forced to grow under adverse conditions flourish better than those which receive the best care. Those under the maximum care will tend to have a sudden collapse in population by disintegrating. Discuss genetic erosion, noting that ideal conditions do not favor the ultimate survival of the species.

3. Assume it is decided by our nation that the reproduction rate must be reduced to 50% of its present rate in order to assure enough resources to avoid the catastrophes attendant with too large a population for the energy available.

   Construct a plan within the restrictions of our present social, governmental and legal systems to control the number of people.

4. Interview the head of the school maintenance department. Obtain from him the cost of damage done to the school during the year. In which part of the school was the damage the greatest? Does this correlate to the number of people in that area?

5. Give examples of the loss of freedom in our legal system as constraints are placed on energy use.

6. Describe the relationship of limited energy resources to social systems such as political, economic, and family.

7. Explain to the class how reduced availability of energy has changed your family's use of the automobile.

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concept: VII - Societal actions influence, extend or exhaust available energy resources.

limits

objective: A - The student will understand how people have an effect upon decisions about themselves.

activities

1. Describe legal considerations of overcrowding.
2. Evaluate what is necessary to implement a policy based on unlimited energy.
3. Visit a township meeting, city council meeting, or county commissioners meeting. Describe:
   a. What problems were discussed due to a limit imposed by an energy source?
   b. What decisions were reached due to a limit imposed by an energy source?
   c. What decisions were reached based upon a policy of unlimited energy availability, limited energy availability, or no energy availability?
4. Role-play an election to clarify how the class can get their views into our system of government, and how they help elect individuals who will support their beliefs.
5. Research "which laws" affect or limit energy use in your city, county or state (e.g. zoning, easements, planning).
6. Visit a legislative body and determine how an "idea" becomes a law.

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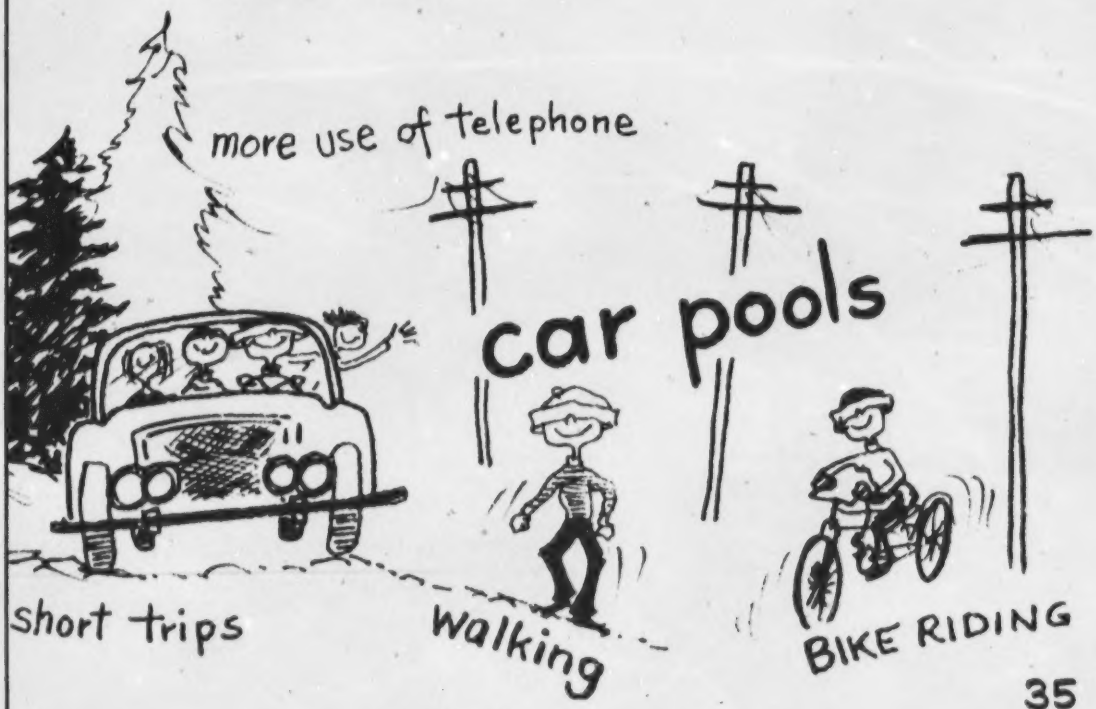
concept: VII - Societal actions influence, extend or exhaust available energy resources.

limits

objective: B - The student will understand how various political decisions can influence use of energy resources.

activities

1. Assume the role of a representative to the United Nations. Argue before that body for a more equitable share of the world's resources.
2. Write down the rules to be used if you had to redistribute the resources of the world.
3. Describe the changes that occur in political systems where resources diminish.
4. Formulate a policy that would more equally distribute the energy resources geographically in the world.
5. Assume you are a Congressman. Write a law which would restrict fuel consumption and be equitable to all sectors of society.
6. Describe the governmental unit which should be responsible for determining the rules under which energy or fuel use might be rationed.
7. Set up the enforcement mechanisms necessary to accomplish orderly reductions in energy use.



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Concept VII
Objective B

8. Study how laws encourage energy conservation or energy waste. Restate those laws to change their effects. Determine what other laws their changes would affect.

9. Debate which of the above concepts should dominate.

10. Consider and understand various kinds of taxes and how they can encourage or discourage energy conservation.

11. Explain how energy use priorities are determined in various societies, such as democratic-industrial, agrarian, totalitarian.

12. Describe historical political decisions which affected use of energy resources, including how they affected them (e.g. Gulf of Tonkin Resolution; Louisiana Purchase).

13. International wars often have been fought because one nation wanted more resources or energy. Review the wars of the world since 1900. Give examples of fighting motivated by the quest for resources.

14. Discuss the ethics of a group or individual that monopolizes a disproportionate share of a resource.

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concept: VII - Societal actions influence, extend or exhaust available energy resources.

limits

objective: C - The student will understand and demonstrate how various segments of our society limit energy resource use.

activities

1. List various groups within our society and the impact of limited energy upon each (e.g. business and industry, labor, the poor, environmentalists, liberals, conservatives).

2. Visit a number of local industries. Describe the constraints put on them by energy resource limits.

   Describe the laws which affect their use of energy.

3. Investigate and describe the various forms of energy used by your community. Then investigate and describe how a change in any one, increase or decrease, will affect the community. (Note: the community can be any size - the home, the classroom, the neighborhood, the town, the county).

4. Make a set of cartoons showing governmental reactions to energy changes.

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concept: VII - Societal actions influence, extend or exhaust available energy resources.

limits

objective: D - The student will describe instances of how decisions benefiting short-term aims affected long term energy resources.

activities

1. Study and report on the desirability of producing electricity from natural gas as compared to using gas directly (e.g. heating water).
2. Discuss what change in energy reserves (oil, gas) occurred as the result of World War II.
3. Debate the question: "Resolved: Oil depletion allowances are economically sound but energy wasteful."

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concept: VIII - Future technologies may be limited by existing resources.

limits

objective: A - Developing technologies depend on availability of particular materials or capacities.

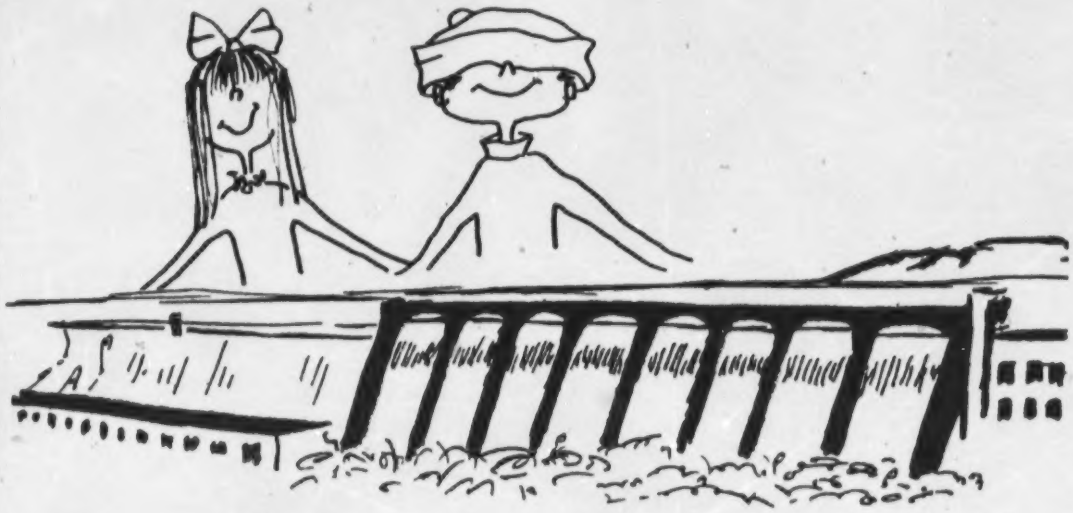
activities

1. Water is a vital part of many industrial applications. Research the consumptive use of water for a given river or body of water in your region. What multiple of the existing plants and water users can be supported without a detrimental effect on the water supply?

2. Magnetohydrodynamics (MHD) is approximately 40% more efficient for using fossil fuels to generate electricity than current methods. Using the latest edition of the Statistical Abstract of the U.S., determine how many additional years U.S. coal reserves will last if MHD is used to generate the same amount of electricity now being produced by coal-fired steam plants.

3. Find out what is meant by the earth's heat budget. Capacity to absorb additional heat is greater in some natural systems than in others and may be viewed as a natural resource. Investigate relative amounts of heat released by fossil-fueled generating plants and nuclear powered generating plants.

4. Electric cars have been proposed as a transport of the future. Present limitations include the need for batteries which will go farther without being recharged. Are these batteries limited by technology or by material costs and availability?



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concept: IX - Limits of energy sources result in the creation of some kinds of jobs and loss of others.

limits

objective: A - Changes in technology which may be required due to energy limits may result in great job displacement.

activities

1. When a resource begins to become scarce, it's due in part to the difficulty of finding it, taking it out of the ground, processing it for use, and transporting it to market.

   Pick an energy resource, oil for example, and discuss what jobs might be created or eliminated as it becomes more scarce; e.g. more jobs for geologists but fewer jobs for gas station attendants.

2. Predict the kinds of jobs that would be eliminated if a severe limit to energy resources were to occur.

3. Assume that it becomes more important to feed available grains to people than to animals. Propose a plan for processing garbage to provide food for sheep, cows, pigs and chickens. List the new occupations that will result from this processing plan.

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